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City of Broken Arrow
Engineering Department
220 S 1st Street
Broken Arrow, OK 74012



City of Broken Arrow
October, 2002

Stormwater Criteria Manual

Additional copies of this manual are available in the Planning Department for \$20.00.

Table of Contents

Section 100 INTRODUCTION

Section 200 STORMWATER DRAINAGE SYSTEM

Section 300 RAINFALL

Section 400 RUNOFF

Section 500 STORMWATER COLLECTION SYSTEM

Section 600 STORMWATER DRAINAGE SYSTEM DESIGN REQUIREMENTS

610 Open Ditch Requirements

620 Drainage Structure Requirements

630 Cross Street Drainage Structure Requirements

640 Stub Street Drainage Requirements

650 Submittals for Street and Drainage Systems

Section 700 STORAGE

710 General Storage Notes

720 Acceptable Types of Storage

730 Detention Facility Design Criteria

740 Fee-In-Lieu of Detention

Section 800 EROSION CONTROL

Section 900 STORMWATER DEVELOPMENT PERMIT

Section 1000 FLOODPLAIN DEVELOPMENT PERMIT

Section 1100 CERTIFICATE OF COMPLIANCE

Figure A Approved Runoff Methods

Figure B Unit Volume Detention Curves

Figure C Runoff Coefficients and Percent Imperviousness

Figure D Travel Time Velocities For Overland Flow

Figure E Storm Frequency Terminology Table

Figure F City of Broken Arrow Example Regulatory Floodplain

Figure G Fee-In-Lieu of Detention Determination Form

Figure H Residential Housing Density vs Impervious Area

Figure I Stormwater Development Permit Application

Figure J Floodplain Development Permit Application

Figure K Certificate of Compliance

Figure L City of Broken Arrow Stormwater Management Ordinance and Amendments

Section 100 Introduction

The design criteria contained herein is known as the City of Broken Arrow Stormwater Criteria Manual. The goal of this manual is to set standard policies for the design, construction, and maintenance of the stormwater drainage system within the City of Broken Arrow, OK jurisdiction. The policies of this manual are presented to develop and promote a consistent and effective approach to the problems of stormwater drainage. Presented are hydrology methods, design factors, and procedures used to determine flow rates, collection, conveyance, and storage of stormwater within the stormwater drainage system. The policies within this manual provide the principles by which all City of Broken Arrow stormwater drainage systems shall be designed and reviewed. Other stormwater design principles shall be considered where sound engineering judgment shows them to be appropriate. However, variances to the policies established herein must have the written approval of the Local Administrator.

Section 200 Stormwater Drainage System

- (a) All stormwater runoff shall be subject to review and approved by the City with regard to analysis, design and construction of drainage facilities. The appropriate public authority shall have the right to maintain, or to cause to be maintained, the drainage system for its intended purposes. If a basin Master Drainage Plan is adopted for the area under consideration, then the provisions of the plan shall be adhered to unless amended.*
- (b) The stormwater drainage system both public and private, may consist of (1) roadways, storm sewers, detention facilities, retention facilities, improved channels; (2) unimproved drainage ways left in their natural condition; (3) the areas covered by drainage way easements for the purpose of providing overland flow; and (4) all appurtenances to the above including inlets, manholes, junction boxes, headwalls, dissipators, culverts, etc. All portions of the drainage system that exist on or in dedicated street rights-of-way or property owned by the City in fee shall be owned and maintained by the City, unless provided otherwise by agreement or covenant. Improved and natural channels on private property shall be maintained by the property owners. In this context, the removal of dead or dying trees or storm debris shall not be considered to alter the channel so as to make it no longer a natural channel.*
- (c) Every development shall be provided with a stormwater drainage system designed by a Engineer registered in the State of Oklahoma, adequate to serve the development, and otherwise shall meet approval requirements of the officials having jurisdiction.*
- (d) The stormwater drainage system shall be designed so that property owners located downstream from and upstream from the development shall not be injuriously affected by the construction, operation, or maintenance of such system.*
- (e) The stormwater drainage system plans prepared and sealed by a Professional Engineer shall show both plan and profile views of the proposed improvements. Any manhole or access point to the system that is buried out of sight shall be dimensioned to permanent objects in the vicinity.*
- (f) The stormwater drainage system shall be designed to receive and pass the runoff from a 1% chance storm under ultimate urbanization. In areas covered by the Regulatory Flood Area, that data shall govern. In areas not covered by the Regulatory Flood Area, the design engineer shall prepare and submit a study area. The ultimate urbanized flow shall be confined within the said stormwater drainage system.*
- (g) A minimum of the 20% chance and 1% chance storms shall be evaluated when designing the stormwater drainage systems.*

Section 300 Rainfall

The Rainfall Intensity Curves prepared for the U.S. Weather Bureau TP-40 and National Weather Service Hydro-35 shall be used for determining the rainfall and intensity values for runoff calculations.

Section 400 Runoff

Figure “A” contains approved runoff methods that may be used for the design of components of the stormwater drainage system as applicable. The Rational Method, SCS Method, Snyder’s Method with Tulsa Modifiers and Unit Volume Method are acceptable methods of determining peak runoff rates and storage volumes. **Figure “B”** presents a simplified unit volume detention curve that may be used to size the detention storage volume required for developments 2 acres or smaller. Any other methods for determining peak runoff and storage volume must be approved in advance by the Local Administrator.

The Rational Method may be used to determine peak flows for design of the stormwater drainage system, but will not be allowed for detention storage volume calculations. Determination of the Rational Method runoff coefficient (C) requires judgment and understanding on the part of the engineer. **Figure “C”** presents the recommended range of C values for specific land uses and surface characteristics. **Figure “D”** presents the overland flow velocities for various ground covers to determine the sheet flow and shallow concentrated flow portions of travel time calculations. Manning’s Formula shall be used to determine the velocity for travel time calculations for concentrated flow within swales, ditches, channels, and storm sewers.

Section 500 Stormwater Collection System

(a) The stormwater collection system shall be designed either:

- (1) To pass a minimum of the runoff from a 20% chance storm in a pipe network together with an overland flow path with capacities so that the combination of the two will pass the runoff from a 1% chance storm under ultimate urbanized conditions.*
 - (2) Or, to pass the entire runoff from 1% chance storm in the pipe network. Should the entire runoff from a 1% chance storm be conveyed in an enclosed drainage network, grading shall be designed to convey the runoff from the 1% chance storm overland in the event of inlet or storm sewer blockage or bypass.*
 - (3) In either case, an overland drainage easement shall be required for overland flows. No overland flows shall be allowed to adversely affect structures.*
 - (4) In areas where overland flows may cause problems, the Local Administrator may require that the entire runoff from the 1% chance storm shall be conveyed through an enclosed drainage network.*
 - (5) In areas where ultimate flows are not planned for conveyance to a regional detention facility, the Local Administrator may reduce the capacity requirement to the existing condition flows.*
- (b) The overland flow portion of the collection system shall be confined to dedicated rights-of-way, or drainage easements to assure the stormwater can pass through the development without inundating the lowest level of any building, dwelling, or structure. All drainage easements shall be shown on the plat.*

- (c) *The distance between inlets, as well as the distance to the first inlet on a street shall be determined by the lesser of the following:
 - (1) For the 1% chance storm, water depth shall not exceed the top of the curb, or
 - (2) 600 feet.*
- (d) *At sump locations, the water depth shall not exceed six (6) inches above the top of curb, or twelve (12) inches above the top of grate, whichever is less, for the 1% chance storm. Where sump collection systems are used, an overflow route shall be provided in the event of a complete blockage of the inlet of pipe. If the inlets and pipe are sized for the 1% chance storm, a sod overflow can be used. If a 20% chance storm inlet and pipe system is designed, the overflow area shall be concrete lined. When a sod overflow structure is constructed, it shall be lined with Bermuda grass or approved equal and shall contain energy dissipators, if required at the outflow point.*
- (e) *Driveway approaches shall be designed and constructed so that the runoff from the 1% chance storm shall not leave the roadway except in locations where the driveway is designed as part of the drainage system.*
- (f) *Runoff from areas greater than one half (1/2) acre outside the roadway of arterial and collector streets shall be collected before it reaches the roadway. In no circumstance shall concentrated flows be allowed to discharge into arterial streets. Parking lots shall have internal drainage systems so as to reduce concentrated flow onto streets. This requirement shall not apply to residential lots used as single-family residences. The Local Administrator may approve sheet flows to the subject streets when connecting to an underground storm sewer system is not economical. In sheet flow instances, the developer must prove no adverse impact to the traveling public, and that the street drainage system is capable of conveying the increased flows.*
- (g) *Site grading shall provide surface water drainage directly into a storm sewer, natural drainage course, improved channel, or paved street without crossing more than four (4) adjacent lots.*
- (h) *No inlets shall be designed for placement within driveways or entries unless individually approved by the Local Administrator.*

Section 600 Stormwater Drainage System Design Requirements

Section 610 Open Ditch Requirements

- (a) *Trapezoidal channels shall be designed with a hard lined flow channel, such as concrete. The low flow channel shall branch off to pick up any storm sewers discharging into the channel. The top of the sides of the low flow channel shall be a minimum of six (6) inches lower than the adjacent main channel bottom, to ensure that the drainage runs over and into the low flow channel and does not erode around it. The minimum cross slope on the bottom of the trapezoidal channel shall be 2%. The easement for the trapezoidal channel shall include a ten (10) foot width on the top of one bank for an access road.*
- (b) *Borrow ditches, when allowed, shall not exceed four (4) feet in depth. Culverts shall be sized to adequately convey the borrow ditch flow. Borrow ditches shall be designed to convey the runoff from the 10% chance storm.*

The ditch side slopes shall be three (3) feet horizontal to one (1) foot vertical or flatter.

- (c) Side slopes for grass-lined channels shall be 3:1 or flatter. Side slopes for concrete lined channels shall be 1:1 or flatter for concrete placed against an existing slope or vertical or flatter where the side wall is formed.
- (d) Culverts in borrow ditches shall be sized to pass the 10% chance storm. Sizing shall be based on the engineer's analysis of requirements. However, the minimum size shall be no less than fifteen (15) inches in diameter
- (e) The street side of a culvert will be no closer than four (4) feet from the edge of pavement or back of curb, closest to the culvert.
- (f) A storm sewer emptying into or collecting water from a borrow ditch will be no closer than four (4) feet from the edge of pavement or back of curb, closest to the culvert.
- (g) Roughness coefficients for channel design will be as listed as in tables 5-5 and 5-6, figure 5-5, pages 109 through 123, of "Open Channel Hydraulics" by Ven te Chow, published by McGraw-Hill Book Company, 1959.
- (h) The maximum velocity in an unlined ditch shall be six (6) feet per second.
- (i) Concrete lined drainage channels shall include the entire channel and one (1) foot above the peak 1% chance storm water surface. When the lining is designed to be constructed with separate sides and bottom, the design shall include the requirement for the bottom to be placed last and it shall cover a minimum of four (4) inches of the sides.
- (j) The centerline radius of a curve on an improved channel shall be a minimum of three (3) times the top width at the design flow or 100 feet, whichever is greater.
- (k) All improved channels shall be provided with a minimum of one (1) foot of freeboard above peak 1% chance storm water surface.
- (l) At all bends in improved channels, the amount of freeboard on the outside wall shall be increased by the following equation:

$$H = V^2(b)/64.4r$$

Where: H is height of freeboard in feet

V is the average velocity in feet per second

b is the width of the channel at the design water surface in feet

r is the radius of curvature of the channel centerline in feet

- (m) The increased freeboard height shall be maintained a minimum of one (1) channel width upstream and downstream of the bend.

Section 620 Drainage Structure Requirements

- (a) Storm sewers may be constructed of reinforced concrete pipe (RCP), coated steel pipe, or double wall polyethylene corrugated pipe, depending on the soil and loading conditions. Minimum pipe size shall be 15" diameter. All design and installation of storm sewer pipe shall meet City of Broken Arrow Standard Construction Specifications.
- (b) All storm drains that discharge into a stream shall have a concrete headwall, wingwalls, and apron. Precast concrete end treatments can be

used with approval of the Local Administrator. Design shall be in accordance with City of Broken Arrow Standard Construction Specifications.

- (c) When the 1% chance storm outfall velocity of a pipe or the velocity in a drainage ditch exceeds six (6) fps, erosion control measures such as energy dissipators and channel lining will be taken at the outfall of the pipe or in the area where the velocity will exceed six (6) fps.
- (d) When RCP is specified, it shall be furnished with omni-flex joints or equivalent. When RCP is specified in a non-cohesive soil, such as sugar sand, and the storm drain is within fifteen (15) feet of a structure that would sustain damage from sinkholes, the City may require wrapping of joints with a non-woven geotextile 6-ounce fabric.
- (e) Where RCP storm sewers cross streets, they shall be backfilled with either ODOT type "A" aggregate base or flowable fill. Where metal or polyethylene storm sewers cross streets, they shall be backfilled with flowable fill following specifications detailed in the City of Broken Arrow Storm Sewer Pipe Bedding Detail (Std. Drawing ST01).
- (f) Culverts shall be sized using either Kutters or Mannings charts, and the Federal Highway Administration's inlet control charts, for the design flow. Approved hydraulics software programs may be used for culvert and storm sewer design also. The slope used for the design shall be the slope of the invert of the culvert.
- (g) The Manning's "n" value for reinforced concrete pipe shall be 0.013. Manning's "n" value for smooth wall corrugated polyethylene pipe shall be 0.012. Manning's "n" value for coated steel or metal pipe shall be approved by the Director of Engineering.
- (h) No pipe shall be installed downstream having a diameter smaller than the pipe from which it is receiving flow unless otherwise approved by the Local Administrator for detention facility purposes.
- (i) Capacity of storm sewer systems downstream from any proposed development producing a measurable increase in runoff shall be investigated. Replacement or adjustment of downstream structures may be required by the City to convey the increased flow from the proposed development.
- (j) Concrete pipe under streets shall not be less than C-76 Class III. For back and side yard installations Class II may be used. Corrugated metal pipes shall meet Oklahoma State Highway Department gauge requirements for fill heights, and bituminous coated and lined. Polyethylene corrugated pipe shall meet the requirements of AASHTO M294.
- (k) Junctions between different pipe shall be made with the top inside of the downstream pipe no higher than the top inside of the upstream pipe.
- (l) A manhole or junction box shall be required at all changes of grade, changes in alignment, and junction between two (2) or more different pipe sizes.
- (m) The horizontal distance between pipes being placed in the same trench shall be a minimum of $2T + 6"$. This would include multiple pipe crossings for culvert purposes.
- (n) Radius pipes will be used only on storm sewers having a diameter of 36 inches and larger. The radius of the curve shall be no less than five (5) times the diameter of the pipe. The degree of deflection shall be no greater

than 7 ½ degrees per joint of radius pipe, or the pipe manufacturer's recommendation, whichever is less. The City is allowed to require radius pipe, should the energy loss be excessive and thereby detrimental to the system.

- (o) A Minimum of six (6) inches cover shall be provided over pipes and box culverts to the bottom of the subgrade except when the box culverts are built with the top at grade.
- (p) When storm sewers are constructed in fill areas, all materials in fill areas shall be compacted to 95% standard proctor density prior to the laying of the pipe.
- (q) Maximum spacing between manholes or junction boxes shall not exceed 400 feet for pipes of fifteen (15) inches in diameter and shall not exceed 500 feet for pipe sizes over fifteen (15) inches in diameter.
- (r) All junction boxes and manholes shall be built with the standard manhole ring and cover at grade in pavement areas and 2" above grade outside of pavement areas.
- (s) A manhole or junction box shall be constructed at the P.C. or P.T. of all curves in sewers.
- (t) All storm sewers shall be shown in profile, showing, size, type, grade, and 1% chance storm flow rates and velocities. Profiles shall show the natural and proposed ground line at the center of the storm sewer. Energy grade line and hydraulic grade line shall be calculated and clearly shown. Stationing shall be continuous through manholes, along the main (longest) line, to the top of the system. Branch lines shall be stationed, starting from 0+00, from their connection with the main line. Lines shall be stationed on the profile drawing from left to right increasing upstream.
- (u) The radius of curve for a box structure shall be a minimum of three (3) times the maximum width of the box structure, but not less than 50 feet.

Section 630 Cross Street Drainage Structure requirements

- (a) *Bridges; New structurally spanned bridges shall have adequate capacity to pass the 1% chance storm ultimate urbanized flows with one (1) foot of freeboard under the low chord. A backwater analysis shall be provided to illustrate compliance with this requirement and to insure there are no adverse downstream or upstream impacts.*
- (b) *Culverts; New culverts under public roads shall have adequate capacity to pass the 1% chance storm ultimate urbanized flows with a maximum water surface elevation not exceeding 6 inches below the lowest pavement (or gutter) elevation in the roadway sump. A backwater analysis shall be provided to illustrate compliance with this requirement and ensure there are no adverse downstream or upstream impacts.*

Section 640 Stub Street Drainage Requirements

When a stub street is included in a subdivision design, it shall include provisions for drainage of the stub street until such time as the stub street is

connected to the extended street system. Design of stub streets will contain the following minimum provisions for drainage:

- (a) Stub streets which drain into the development under design will not require special drainage structures.*
- (b) Stub streets which drain away from the development will require a drainage easement on the adjoining property with a 1% chance storm flow capacity ditch to a point of natural drainage or concrete curb & gutter across the end of the street, with storm inlets tied to an operational storm sewer system.*

Section 650 Submittals for Streets and Drainage Systems

The following items are required for approval of street and drainage plans:

- (a) Soil test results*
- (b) Geotechnical engineers report*
- (c) Pavement design report*
- (d) Hydrology and Hydraulics report (drainage)*
- (e) Storm sewer and drainage plans including as a minimum, tabulation sheet, plan sheets, profile sheets, drainage structure summary sheets, and standard details.*
- (f) Street plans including as a minimum, plan sheets, profile sheets, cross-sections, and standard details.*

Section 700 Storage

Section 710 General Storage Notes

- (a) Detention storage shall be required to accommodate excess runoff from all storms from the 20% chance storm up to the 1% chance storm. Excess runoff is that runoff generated due to urbanization which is greater than the runoff historically generated under existing conditions, for a given frequency storm. Detention facilities shall be designed so that the peak rate of discharge does not exceed that of the existing conditions.*
- (b) Peak release rates from private developments shall not exceed the existing runoff that occurred before private development for all storm frequencies up to and including the 1% chance storm. The 20% chance, 10% chance, 2% chance, and 1% chance storms shall be investigated at a minimum.*
- (c) Public regional detention facilities may be designed with 1% chance storm outflow rates equal to or lower than pre-development values with possible increased flow rates for the 20% chance, 10% chance, and 2% chance storms from pre-development flow rates under those conditions where downstream areas are not adversely impacted.*
- (d) If the development is situated in such a manner that the stormwater is discharged into a stormwater system which the Local Administrator determines will not be adversely affected, the developer may make a monetary payment or some other form of valuable consideration to the*

City in accordance with Section 25-207 of the Stormwater Management Ordinance, in lieu of constructing an onsite detention facility.

(e) Changes may be made to streams or channels within the Regulatory Flood Fringe Area; subject to approval of the Local Administrator, provided that:

- (1) The volume of floodwater storage is not reduced;*
- (2) Neither downstream or upstream water surface elevations are adversely increased; and*
- (3) All required permits are obtained prior to starting work*

Section 720 Acceptable Types of Storage

Acceptable types of detention or retention facilities:

- (a) Dry detention facilities: Such facilities must be provided with underground drainage or a concrete trickle channel to eliminate standing water after storm periods. This type of facility may be used for recreational purposes and other approved uses to the maximum extent possible when not functioning as a detention facility.*
- (b) Wet detention facilities: Such facilities will be used on a limited basis and will be approved only when the pond inflow is sufficient to maintain pond water surface levels and to preclude the water from stagnating.*
- (c) Underground detention facilities: This type of facility may consist of basins, tanks, and or oversized storm sewers.*
- (d) Parking lot detention: This type of facility may be used provided the maximum 1% chance storm ponding depth is twelve (12) inches or less. Any repaving of the parking lot shall be evaluated for impact on volume and release rates and are subject to approval by the Local Administrator. All parking lot detention areas shall have a minimum of two signs posted identifying the detention pond area. The signs shall have a minimum of 1.5 square feet and contain the following message:*

<p style="text-align: center;">“WARNING” “This area is a Stormwater Detention Facility and is subject to periodic flooding to a depth of (provide 1% chance storm design depth).”</p>
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Any suitable materials and geometry of the sign is permissible, subject to approval by the Local Administrator.

- (e) Retention facilities: Such facilities may be used when the existing conditions runoff from a watershed would exceed the capacities of downstream facilities. The retention facility shall contain the 1% chance stormwater runoff and release shall be by evaporation, infiltration or slow release at outflow rates less than existing levels.*

Section 730 Detention Facility Design Criteria

- (a) The design storm for detention facilities shall be a 24-hour storm.
- (b) The three allowed methods for detention facility design are SCS Method, Snyder's Method with Tulsa Modifiers and Unit Volume Relationship Method. See **Figure "A"** to determine applicability of each method.
- (c) The time increment used in developing the rainfall distribution shall be rounded off to the nearest whole time interval or to the nearest time increment. For the 24-hour storm, the maximum time increment shall be 5 minutes.
- (d) The rainfall patterns shall be used in accordance with the modeling technique selected.
- (e) For Snyder's Method with Tulsa Modifiers, the loss rates in determining the runoff/hydrograph shall be an initial loss of 0.5 inches and a uniform loss of 0.08 inches per hour for the subsequent hours once the initial losses are satisfied.
- (f) All calculations for detention facilities shall be submitted for review by the City. The submittal shall include:
 - (1) The 20% chance, 10% chance, 2% chance, and 1% chance storm hydrographs for the proposed development and all upstream areas draining through the proposed development for existing and post-project conditions shall be determined. The detention facility and stormwater drainage system shall be designed to convey any offsite runoff that drains to it.
 - (2) Detention facility stage/area/outflow or stage/volume/outflow relationships.
 - (3) A stage versus time analysis through the facility.
 - (4) Outlet structure details.
 - (5) Applicable orifice or weir flow calculations for outlet structure and overflow spillway.
 - (6) Existing conditions and post-project conditions drainage area maps.
 - (7) For SCS Method, list soil classifications, curve number assumptions, and time of concentration/lag time calculations.
 - (8) For Snyder's Method, list time to peak (TL), peaking coefficient (Cp), and peak of unit hydrograph flow rate (qp) calculations.
 - (9) Supporting documentation to include HEC runs, a list of assumptions, and other data required to validate the information provided.
- (g) All dikes and spillways on detention facilities shall have typical cross sections shown on the plans.
- (h) Side slopes on detention facilities shall not be steeper than 3:1 (Horiz:Vertical)
- (i) Detention facilities shall be provided with a concrete trickle channel from the inlet(s) to the outlet structure to transmit low flows. The minimum slope of the bottom of the pond and trickle channel shall be 0.50%.
- (j) The detention area shall be identified as a separate platted area; as appropriate, it may consist of one or more platted lots, a separate block, a reserve area, or it may be dedicated by separate instrument. No detention facilities will be allowed in off-tract areas without written agreement between affected property owners and said agreement must be filed and recorded in County land records.

- (k) Provision for the maintenance responsibility of private detention facilities shall appear among the plat's restrictive covenants, or applicable law.
- (l) In the event a detention facility, as a result of drainage improvements, becomes unnecessary, the facility by action of the City Council may be vacated as provided for in the covenants or under applicable law.
- (m) An access way at least twenty (20) feet wide shall be provided to any detention area. Access may be provided by frontage on a dedicated public street or by an access easement from a public street to the detention area. The access road shall have a maximum grade of twelve percent (12%).
- (n) If a detention facility is approved by the City to serve areas outside the development in which it is located, such additional areas shall be specifically identified in the provision for detention.
- (o) Any dam or berm constructed shall be designed by an Oklahoma Registered Professional Engineer.
- (p) Any dam constructed for the purpose of storing water and under the jurisdiction of the Oklahoma Water Resources Board shall be designed in accordance with the "Rules and Regulations" published by the OWRB. Any barrier that is not in excess of six feet in height, regardless of storage capacity, or which is not in excess of 15 acre-feet of storage, regardless of height, may not be subject to the strict regulation of the OWRB.
- (q) All detention dams or dikes shall be constructed as earth filled and non-overflow type dams. Embankment slopes shall not be steeper than 3:1. Earthen portions of the dam structure shall have a minimum of one foot of freeboard above the 0.2% chance storm event. Flows above the 1% chance storm event are not required to be detained. Freeboard requirements may be adjusted for detention facilities not utilizing earthen berm dams by the Director of Engineering.
- (r) All detention facilities shall be constructed with an emergency spillway structure designed to pass the flow from the 1% chance flood event in the event of blockage of the outlet structure. Erosion control in the form of concrete lining, rip-rap, dissipator blocks etc. will be provided where deemed necessary.
- (s) All earth slopes and areas subject to erosion, such as, adjacent to trickle channels, inlet structures, and outlet structures, shall be slab sodded with Bermuda sod or protected with other erosion control measures. All other earth surfaces, within the designated detention area, shall have an established growth of Bermuda grass. All grass covered areas shall be fertilized, watered and in an established growing condition prior to completion and approval of the detention facility.
- (t) Construction of the detention facility shall occur before or in concurrence with construction of other proposed impervious areas onsite including buildings and parking lots.
- (u) The Engineer of record shall submit a signed and sealed hydrology\hydraulics report in the following format:
 - 1. Bound in an appropriate 3 ring binder.
 - 2. The outer cover shall list the Project Name, Engineers Name and Seal, and the City of Broken Arrow's assigned development number.
 - 3. The report shall include at a minimum the following:
Title sheet

Table of Contents

List of figures

List of tables

Written summary of project

Maps outlining all contributing drainage areas.

Pre and post project hydrographs routed through detention facility

Detention facility grading plan and outlet structure details.

Plan and profile of the storm system showing the hydraulic gradient of the entire system.

Digital copy of all files associated with the report. If the City is not familiar with the software, the City may require documentation of the software operations.

Section 740 Fee-in-lieu of detention

*When approved by the Local Administrator, a developer may make a monetary payment or some other form of valuable consideration in lieu of building a detention facility. The developer or engineer shall fill out and turn in a **Fee-In-Lieu of Detention Determination** form as included in **Figure "G"** to the Local Administrator. The Local Administrator shall make the determination of whether fee-in-lieu of detention will be allowed based upon capacity of the receiving stormwater drainage system and whether regional detention facilities are either proposed or in place. The amount of the fee shall be based on the number of square feet of impervious area added to the property. The developer shall provide the Local Administrator calculations of the number of square feet of increased impervious area and the Local Administrator shall prepare a bill for payment in-lieu of detention. For increased impervious area calculations, existing impervious area shall be defined per conditions on the site dated March 4, 1999. The square footage of increased impervious areas for proposed residential developments shall be determined from the **Residential Housing Density vs. Impervious Area** graph shown on **Figure "H"**. To determine the impervious area, obtain the total platted area minus open space areas or reserve areas greater than 0.5 acres divided by the total number of residential units to determine the impervious percentage from **Figure "H"**. Multiply the impervious percentage from **Figure "H"** by the total platted area minus applicable reserve or open space areas to obtain the proposed impervious area. The square footage of increased impervious area shall be shown immediately above the title block in the lower right hand corner of both the site plan and engineering plan cover sheet for both residential and non-residential projects. The fee shall be paid at the time the final plat is released for residential developments. The fee shall be paid prior to issuance of building permit for non-residential developments. When these fees are collected, they shall be deposited into a Stormwater Capital Improvements Fund, which will be used for future or ongoing stormwater improvement and regional detention projects.*

Section 800 Erosion Control

Erosion control shall be provided during the construction phase on all construction sites as necessary to prevent impacts to offsite areas and/or public

rights-of-way. The primary goal of erosion control and best management practices is to minimize erosion and sedimentation during construction activities until final grading, landscaping and storm sewer structures are in place. Best management practices include but are not limited to seeding, sodding, sprigging, silt fences, straw bale dikes, earth dikes or swales, temporary stream crossings, storm sewer inlet protection, temporary sediment basins, and stabilized construction entrances. Failure to provide sediment and erosion control protection can result in suspension of the earth change, stormwater development, and building permits. A violation of this Section 25-402 by the failure to comply with any of its requirements shall constitute a Class D offense, and any person or entity convicted thereof shall be punishable as set forth in Broken Arrow Code. Provided, that each lot upon which such violation occurs shall constitute a separate offense; and each day on which a violation occurs or is allowed to remain shall constitute a separate offense. The imposition of criminal sections shall not prevent Broken Arrow from taking any lawful action as is necessary to prevent or remedy a violation. A Stormwater Pollution Prevention Plan is required for sites over 1 acre.

Section 900 Stormwater Development Permit

*A Stormwater Development Permit shall be obtained prior to any development on projects that require platting, site plan approval or alterations to existing public stormwater drainage systems. The Stormwater Development Permit fee set by ordinance shall be submitted with the permit application. A copy of the **Stormwater Development Permit** form is included in **Figure "I"**. The minimum submittal requirements are as follows:*

- (a) Name and Address of legal owner.
- (b) Legal description of property.
- (c) Boundary line survey.
- (d) A location map at 1" = 2000' scale shown on plans.
- (e) Title of project or property shown on plans.
- (f) Existing and proposed contours at 1' or 2' intervals or spot elevations with drainage arrows.
- (g) Existing storm sewer and natural features on site and on adjacent properties within fifty (50) feet of the site boundary line.
- (h) Manhole top of rim elevations to be shown on plans. If needed, show manhole adjusted to grade with proposed elevation.
- (i) Silt fence, hay bales, ditch checks, and any necessary erosion control shall be shown on plans with details and notes.
- (j) Permanent erosion control on the plans in areas of concentrated flows.
- (k) Plans to show no increase of runoff unless development is within a subdivision with an approved detention facility or fee-in-lieu of detention has been approved. A table comparing existing conditions to proposed conditions with drainage areas clearly labeled shall be included.
- (l) Runoff will be conveyed to a storm sewer system before entering public streets per Stormwater Criteria Manual Section 500(f). Profiles

of storm pipe with 20% chance and 1% chance peak flow rates and velocities shall be included.

- (m) Three sets of the Grading, Drainage and Storm Sewer Design Plans will be signed and sealed by an Oklahoma Registered Professional Engineer and submitted to the City of Broken Arrow Engineering Department.

The Local Administrator shall have the right to waive sections of the permit requirements, subject to the developer providing adequate proof, to the Local Administrator; the development does not cause adverse impact to the community.

Section 1000 Floodplain Development Permit

*A Floodplain Development Permit shall be required to assure conformity with the provisions of this chapter and to insure that new development is constructed in a manner that minimizes exposure to flooding. A Floodplain Development Permit shall be obtained before construction or development begins in any area in the Regulatory Flood Area established in section 25-304. Application for a Floodplain Development Permit shall be made on forms furnished by the Local Administrator. Application for a **Floodplain Development Permit** shall be made on the form included as **Figure “J”**. The Floodplain Development Permit fee and submittal requirements set by ordinance shall be submitted to the Local Administrator with the permit application.*

Section 1100 Certificate of Compliance

A copy of the Certificate of Compliance form is included as **Figure “K”**.

- (a) *In the Regulatory Flood Area, as determined by documents enumerated in Section 25-304, it shall be unlawful to occupy or permit the use or occupancy of any building or premises, or both, or part thereof hereafter created, erected, changed, converted or wholly or partly altered or enlarged in its use or structure until a Certificate of Compliance has been issued by the Local Administrator stating that the building or land conforms to the requirements of this ordinance.*
- (b) *A Certificate of Compliance shall be issued by the Local Administrator upon satisfactory completion of all development in the Regulatory Flood Area.*
- (c) *Issuance of the certificate shall be based upon the inspections conducted as prescribed in Section 25-507, and/or any certified elevations, hydraulic data, floodproofing, anchoring requirements or encroachment analysis which may have been required as a condition of the approved permit.*

**NOTE: ALL TEXT IN ITALICS IS FROM THE CITY OF
BROKEN ARROW STORMWATER MANAGEMENT
ORDINANCE NO. 2443**